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A THEORY

OF

THE UNIVERSE

> “And for the heavens' wide circuit, let it speak
> The Maker's high magnificence.”—MILTON.

> “The heavens shall vanish away like smoke. and the earth shall wax old like a garment.”—ISAIAH, lxi.. 6.

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PREFACE.

THE author of this essay is not the originator of the THEORY propounded in it. The work from which he has principally compiled this was published in London several years ago. The subjects, as here presented to the public, have no tincture of opposition to religious views, and the author humbly hopes that what he has offered for perusal may awaken in the mind of the reader an adoration for that BEING who created and sustains all things.

In this work it is our object to show, by facts and inferences, that the earth has been formed from gaseous matter, which had, in the first instance, issued from the sun, but subsequently passed from the gaseous to the liquid state, and is now passing into an entire solid form; that the earth is gradually approaching the central sun, as is also the case with all the planets of the solar system.

We assume that a gaseous fluid is continually issuing from the sun, and pervading the whole solar system; that this fluid cannot return to the sun in the gaseous state; that when it has been condensed it must of necessity be attracted toward the sun; that the materials of which comets are formed are derived from the sun; that the conglomeration of the particles is effected by mutual attraction, aided by a rolling or twisting motion in the solar gaseous fluid in its passage through the field of contracting particles; that as a comet approaches the centre, the action of the sun causes the formation of a tail—therefore the comet cannot fall into the sun, but is drawn off by the tail; that the comet continues to condense or harden; that at each succeeding revolution the tail is less and less expanded, and the eccentric orbit is continually widened by the action of the sun upon the tail, till, after a series of revolutions, the orbit is reduced to the planetary form, and the pulpy mass to the consistence of a planet, capable of supporting vegetation and ultimately animal life; that the planet is continually hardening or contracting, and in the same proportion gradually approaching the sun; that the earth before she reaches the sun will have become a solid body—all life, both animal and vegetable, will have become extinct; and as from this solid body no tail can be formed, the earth will fall into the sun, where she will be decomposed, and again issue in the form of a gaseous fluid. And we assume, that at an early period of the earth's existence she was attended by several satellites, each of which has, in the order of their succession, been precipitated upon the earth; that the remains of these former satellites form a great portion of the present surface of the earth, and that the remaining moon is now approaching, and will finish her course with a similar catastrophe, as will also be the case with the satellites of Jupiter, Saturn, Uranus, and Neptune.

"There is," says De La Beche, "so much grandeur and simplicity in the idea of the condensation of gaseous matter into those spheres or spheroids which exist not only in our solar system, but also by myriads throughout the universe, that we are irresistibly left to adopt some view of this kind, more particularly as it would accord with the unity of design so evident throughout the creation. Encke's comet, that remarkable body of vapor which revolves around the sun in about three and one-third years, proves by its existence that gaseous matter or vapor of extraordinary tenuity may float around our great luminary in given times, and in a given orbit, checked only by a resisting medium of still more extraordinary tenuity. There is, therefore, no argument *a priori* against the hypothesis that the matter composing our globe may once have existed in a gaseous state, and in that state have revolved around the sun."

A geological truth must command our assent as powerfully as that of the existence of our own minds. President Hitchcock says: "Geology is not indeed insensible to the displays of the divine character which are exhibited on the present theatre of the world. Indeed, she distinctly recognizes the act which is now passing as the most perfect of all. Yet this scene of the great drama she regards as only one of the units of a similar series of changes that have gone by, or will hereafter come; the chain stretches so far into the eternity that is past and the eternity that is to come, that the extremities are lost to mortal vision."

Those who have not devoted much time to the study of works on chemistry, geology, and astronomy, may be induced, on reading this essay, in which deductions are drawn from such works, to enlarge the field of their inquiry respecting them. And those who are already familiar with the sciences referred to, may find in this brief essay something to engage their minds awhile. So hopes

THE AUTHOR.

Cambridge, Mass., 1868.

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A THEORY OF THE UNIVERSE.

SECTION I.

REMARKS ON MATTER, SHOWING THE EFFECTS OF ATTRACTION AND REPULSION.

MATTER is presented to our notice in three distinct forms—solid, liquid, and gaseous. The world which we inhabit is made up of these three descriptions of matter, —the solid earth, the liquid ocean, and the gaseous atmosphere. The solar system itself is made up of these three kinds of matter. In the sun and planets are to be found the solids and liquids, with the respective atmosphere of each body; and the whole solar system is connected together by a gaseous medium of a subtle character, denominated ether or the ethereal medium, which pervades the entire intervening spaces between the sun and the different planetary bodies of the solar system. Experimental philosophy has established the fact, that all matter may exist in either of these three forms; that the most contracted solid may be expanded into an invisible gas, and that the most expanded gas may be contracted into a hard solid.

"Matter is the only thing upon which material action is told to our comprehension, and the result may be the consolidation of a globe, such as the earth, out of matter so far dispersed over space, and so thin that a volume of it larger than anything which we can measure or name would not amount to the millionth part of the smallest grain of sand; and, as space is boundless, and the extent to which gravitation extends is equally so, at least to our comprehension in both cases, this may be the mode in which new worlds are formed out of the ruins of former ones, which have been so scattered over space in an ethereal fluid, fine beyond all comprehension—beyond the ken not only of man but of the superior intelligence of the brightest spirit which is before the throne, and thus known only to Him who is All-seeing as well as All-powerful. As it is written, God created all things out of nothing; and it is a most striking confirmation of this sacred truth, that we can follow not only substantive matter, but all those actions to which the various forms and changes of matter are owing, down to the very bourne of nothingness.

"While the sun shines upon the surface of a country, the influence of his beams produces a countless number of results, and some of them, to all appearance, the very opposite of each other. Some substances are consolidated, some are melted, some are turned into vapor, and some into gas; so that, in consequence of the diversity of nature in substances, there is scarcely one imaginable operation which does not take place; and all the variety, all the beauty, and all the usefulness, which so charms us, and so ministers to our wants, on field or flood, on mountain and forest, and in everything that lives, or grows, or exists, is all brought about by the operation of one single cause—the beams of the all-stimulating sun."

Universal space is the great laboratory of nature, in which all her operations are performed. Eternity is the era of nature; her operations have no limits either in time or space. We see certain conditions exist throughout the solar system, and although we cannot demonstrate that the same conditions prevail throughout universal space, the inference that the same conditions do prevail universally is legitimate and rational, more especially as every fixed star—and none of them can be less than nineteen trillions two hundred billions of miles from the earth—appears to be the centre of a system. We learn from astronomical and geological facts that a great chain of physical processes, requiring thousands of millions of years for their accomplishment, have been and are now going on in this earth and throughout the solar system of which the earth forms a part.

"We have no alternative but to refer the origin of material substance and that of material action to One and Almighty Creating Cause, and to consider the origin of the one as perfectly simultaneous with that of the other. In the whole system of nature, there is nothing left alone and allowed to exist and act of and for itself only. If there is any power, or principle, or energy, which would, if left to itself, produce any final result, we find that there is along with it an antagonist, which, if left alone to work by itself, would produce a final result exactly the opposite of that of the former. Every substance is held by these as in a balance. The working of the system of nature is by the providence of Nature's ALMIGHTY AUTHOR."

How true is the sentiment of the poet who says:

> "There lives and works
> A soul in all things, and that soul is God;
> Through all diffused,
> The life of all that lives."

All matter is in a state of continual change from the gaseous empire to the liquid empire; from the liquid empire to the solid empire; from the solid empire to the liquid empire; and from the liquid empire to the gaseous empire again, which round of changes constitutes the great chain of cause and effect, or grand circuit of motion of the physical universe, of which the smaller operations of nature are but the subordinate links. If a solid is forming at one point, there must be of necessity a gas forming at another point, however distant that point may be. In proportion as matter is abstracted from the gaseous empire and absorbed into the solid, in the different planets and comets of the solar system, so, in the same proportion, is matter abstracted from the solid empire and given back to the gaseous by the internal action of the sun; and thus is the equilibrium of the two opposite empires maintained, and, for aught we know to the contrary, thus will the equilibrium be maintained to all eternity; worlds after worlds being formed and dissolved in everlasting succession, but the solar system remaining forever.

ATTRACTION and REPULSION are ultimate, opposing and universal FORCES, inherent in matter, equal in power and extent, and all matter is at all times and in all places under the action of both these forces, and is held exactly in the position which it occupies in the universe. If the two forces were at all times and in all places in a state of perfect equilibrium, all nature would remain in a state of rest; gas would forever remain gas, and solids would ever remain solids. When repulsion is the stronger or predominating force, matter continually expands until it has reached the ultimate point of expansion—an example of which is the celestial ether which fills all space. When attraction is the stronger or predominating force, matter continually contracts until it has reached the ultimate point of contraction—an example of which may be seen in the crystalline matter of which the solid earth is composed. Repulsion acting at the surface and also at the bottom of the ocean causes water to expand into vapor; in consequence of which expansion it rises into the atmosphere to a greater or less altitude, in proportion as it is more or less expanded. The mechanical motion of the piston, beam, fly-wheel, and other parts of a steam-engine, derive their motion from this cause, as well as all the machinery which is attached to it. Attraction acting upon the vapor and gas in the atmosphere causes it to contract; in consequence of which contraction, it falls or descends to the surface of the earth, in the form of a spherical raindrop, or in flakes of snow. This rain, or hail and snow when melted, falling on the tops of mountains, trickles down their sides in small streams, which continually flowing into larger and larger currents, are at last collected into rivers, and thus carried back into the ocean. We thus find that the moving matter has performed a CIRCUIT, and that the motion throughout this circuit was derived from the two forces of repulsion and attraction, causing its expansion and contraction. The mechanical motion of water-wheels and of the machinery thereto attached, is an effect resulting from attraction or the contraction of the water, as that of the steam-engine from its expansion. In relation to the various processes going forward in the earth, we are enabled by observation to trace all motion to the expansion and contraction of matter; or, in other words, the equilibrium between the two forces of attraction and repulsion being continually disturbed, motion is the result, and the line of motion is modified by momentum.

The game of battledore and shuttlecock cannot be played by one, nor yet by two, unless they stand opposite each other, and propel the shuttlecock in contrary directions; neither could the system of nature be carried on but by two forces—attraction and repulsion—opposing each other in a similar manner. When masses of matter are moved without expanding or contracting, which is mechanical motion, their motion is always caused by and is an effect of the expansion or contraction of other matter, as the surface of the earth is heaved up in earthquakes by the expansion, or when the surface sinks by the contraction of matter beneath.

Expansion of matter is an effect of the repulsion of atoms, and constitutes chemical decomposition, the ultimate resultant being an invisible gas. Contraction of matter is an effect of the attraction of atoms, and constitutes chemical combination, the ultimate resultant being a solid body. If expansive motion continually tends from the centre to the circumference, a perpetual expansive motion is impossible; because, whatever may be the dimensions of the mass, it must have a centre, at which point expansive motion must cease. If contractile motion continually tends from a circumference to a centre, a perpetual contractile motion is impossible; because, whatever may be the dimensions of a circle, it must have a centre, at which point the contractile motion must cease. But a perpetual motion may and does exist in nature, and is a necessary result of the two forces—attraction and repulsion—and they may and will continue to produce motion forever.

There is, then, an ultimate point of expansion and an ultimate point of contraction. These ultimate points are different in different bodies, but in every case the natural ultimate point, which terminates the process, is at an immense distance from the possible ultimate point. Throughout universal nature, there is no portion of matter in a state of absolute rest; all is in motion, and the range of that motion is in every case comprised within these two natural ultimate points, between the one and the other of which, matter, or the motion of matter, continually oscillates, without pause or cessation. In some cases an oscillation is finished in few months, or less; in others millions of years are required.

Professor Liebig says, that " A view of the physical constitution of bodies, first propounded by Dalton, agrees so perfectly with all the phenomena which composition and decomposition present, and such numberless analogies prove the same, that at present it must be regarded as the true expression of the reasons of chemical proportions. According to this view matter is is not infinitely divisible, but there exists a limit beyond which the particles of a body cannot be further divided."

In every circuit of motion there must be at least one expansion and one contraction of matter. Wherever we turn our eyes we may discover natural circles of motion. The animal body is a bundle of circles of motion. It is a little system within itself, having points of connection with external nature, working upon the same principles. It contains or rather consists of a variety of circles, the highest of which is the nervous. The nervous system is the primary circle, from which the inferior or secondary circles derive their energy; and this primary circle is actuated, moved or excited by electrical agency; and in the same manner the inferior or secondary circles of the external world derive their energy from the primary circle, which primary circle is actuated, moved or excited upon electrical principles. A circuit of motion, like every other circle, has, properly speaking, neither beginning nor end. We may begin anywhere, but we must always trace it around to the starting point. Whether in the animal, vegetable, or mineral kingdom, or in the more extended field of what is denominated inorganic nature, there is no single circle of motion working by itself in an isolated state, wholly unconnected with or independent of other circles. Nature, considered as a whole, is, like the interior of a watch, a beautiful system of wheel-work, whose mainspring is electricity, which, by its alternate attraction and repulsion, is everywhere producing the contraction and expansion of matter. In short, every atom, and every aggregate of atoms in the universe, is at all times and in all places subject to the powers of electricity.

If man could trace the expansions and contractions of matter through every form and condition, then would all the secrets of nature stand revealed. Take a common tallow candle, which is formed of solid animal matter, and therefore in that state belongs to the solid empire, and which, by the ordinary process of nature, would in time pass off into the gaseous empire; but if you light the candle, the process will be quickened. When the candle has been lighted, the solid animal matter begins to decompose, taking the liquid form in the little cup which is formed round the wick immediately under the flame; from the liquid in this little cup, it is further decomposed into two or more gases; these gases instantly combine with the oxygen of the atmosphere, and heat and light are given out in the process; or, to speak more correctly, perhaps, we ought to say that heat and light are effects resulting from the act of chemical combination. Now, after a certain time, the candle is burned out or consumed, as we say in common language; but not a particle of the solid matter has been lost; the whole has passed off into the gaseous empire. Hydrogen and carbon are two of the constituents of the candle, and as it continues to burn, these two bodies continue to combine with the oxygen of the air, the hydrogen and oxygen passing off in the form of steam, and the carbon and oxygen in the form of carbonic acid gas, both gases mixing with the atmosphere. After a time the steam is condensed or contracted into water, and falls upon the earth, and the carbonic acid gas, from its specific gravity, floats near the surface. Now, water and carbonic acid are the food of vegetables; therefore, if they fall upon a field of grass, the grass will grow and thrive upon this matter. If sheep or other herbivorous animals are fed in this field, the sheep will thrive and fatten upon the grass, and when the sheep are fatted and killed we may procure our tallow candle again with which we commenced the process. Here we have the circuit of motion again, and every step of this circuit has been carried forward by the expansion and contraction of matter; the matter has passed from the solid to the gaseous empire, and, *vice versa*, from the gaseous to the solid empire. We have traced the matter through the vegetable and animal kingdoms, but the connection does not stop here; we may trace the same matter through every cranny and corner of the solar system; nor is it likely that the connection stops even here, but that every part of nature is more or less connected, forming one grand harmonious whole.

Again, take a piece of coal, which, in the condition in which it is found, is to be considered a mineral body, although it is evident, upon a very slight inspection, that it once existed upon the earth's surface in a vegetable state. Throw it upon the fire, and, as in the former case of the candle, we have carbonic acid and steam, with other gases resulting from the decomposition of the coal and their combination with the oxygen of the atmosphere; and these gases, obtained from the decomposition of a bed of coal, will feed a forest, which forest may again form a bed of coal. Here we have passed through the vegetable and mineral kingdoms, and here again we have the circuit of motion; each step of which circuit is dependent upon the expansion and contraction of matter. We might go on adding examples without end.

Now, it is evident, if in this earth solid matter were dissolved and passed off into gas in exactly the same proportion that gaseous matter is passing into the solid state, that this alternate action or process might go on forever, without the whole earth passing into the solid state, as is affirmed by this theory. But such is not the fact. In this earth the contractive force is the stronger of the two, just as in the sun the expansive force is the stronger, the effect of which is, that in this earth the solid empire is continually gaining upon the gaseous, and in the sun the gaseous empire is in like measure gaining upon the solid; and thus the equilibrium of the two is maintained. The solid rocks of the earth contain within themselves evidence, of the most indubitable character, that the matter of which they are composed has passed from the fluid to the solid form, and the process of contraction is still going on. But this process cannot go on forever; neither is there any known power on earth by which they can be dissolved and given back to the gaseous empire, from which they have been derived, and to which they must return before the circuit of motion can be completed. The grand focus of electricity is the sun; to which focus the planets are all tending, where their solid materials will be decomposed and again given back to the gaseous empire.

When we see the lightning flash and hear the thunder roll over our heads, the concussion of elements finishing with the descent of a vast body of water, we seldom stop to inquire by what physical cause these great effects are brought about. Now, take a pint of water, and subject it to the influence of the galvanic battery in the usual way; the water will be decomposed into two constituent gases, oxygen and hydrogen, by which it will be expanded into about 2,000 times its former volume—that is, the two gases will fill about 2,000 pints. If the experiment be conducted without any preparation for retaining the gases in close vessels, they will escape into the air, and will for a time form a part of the atmosphere. But if the oxygen and hydrogen gases be collected in two separate vessels, and afterward passed carefully into one, the gases will become blended together, though still retaining the gaseous form. If now the electric spark be passed through the mixed gases, a flash and explosion will instantly follow, and the 2,000 pints of gas will be found contracted into one pint of water as at first. In this experiment we have, upon a small scale, imitated the process that is going on in the open theatre of the world; we have prepared the materials for, and finished our experiment with, the exhibition of a small mimic thunder-storm; we have brought into action the two powers by which the operations are carried forward—repulsion and attraction, producing the expansion and contraction of matter.

It must not be supposed that all the water which falls upon the surface of the earth, in the form of rain, has been previously decomposed into its ultimate gases; a very large proportion ascends from the surface into the atmosphere in the state of vapor, where it is held for a time in suspension, until, meeting with a current of cold air, it is contracted into rain-drops, in a manner analogous to the condensation of steam. An immense body of water in the expanded form is continually passing from the ocean into the atmosphere, and although, to our comprehension, the extent of the ocean seems almost unbounded, yet it is a finite quantity. Every season a certain quantity of water is drawn from the ocean to sustain the vegetation of the earth. When the vegetable dies and falls upon the surface, a portion of the matter of which it is composed returns to the gaseous empire, from which it has been recently derived; but a very considerable portion passes onward to form vegetable mold. Year after year this mold accumulates, until ultimately a bed of earth is formed; and this bed of earth, in process of time, becomes mineralized into a bed of stone. A portion of the water which falls upon the earth in rain-drops never returns to the ocean, but is taken up in feeding the vegetation of the earth, where it passes into the solid form, which solid matter is transferred to the mineral kingdom, where it will in all probability remain; yet still contracting into a harder state, till it is dissolved into gas.

SECTION II.

DEDUCTIONS FROM CHEMISTRY.

THE study of chemistry, in the abstract sense, is simply the study of the two ultimate forces of attraction and repulsion. But as these forces are invisible, we are necessitated to apply ourselves to the study of the effects resulting from the operation of these unseen causes. The effects are tangible and discernible to the senses; they are the decomposition or expansion of solid bodies into gases by repulsion, and the decomposition or contraction of gaseous matter into solid bodies by attraction.

We see around us in nature a great variety of substances which are formed from a few simple elements. It must be ever kept present to the mind, that any new compound can only be formed by the decomposition of another compound. Repulsion separates, decomposes or expands solids, and the liberated matter sometimes passes off in the form of gas, but it is impossible for the matter to pass from one solid into another, without passing through the liquid or gaseous form.

We learn from writers on chemistry, that through the union of certain conditions, whose connection is denominated an experiment, generally by the mutual contact of bodies, with the application of heat, from a great number of substances others can be extracted of entirely different properties; a limited number of bodies, however, suffer no change when so examined; these are named SIMPLE BODIES—chemical elements, some of which, alphabetically arranged, are as follows: Aluminum, antimony, bromine, calcium, carbon, chlorine, fluorine, gold, hydrogen, iodine, magnesium, manganese, mercury, oxygen, palladium, phosphorus, platinum, potassium, selenium, silicon, silver, sodium, sulphur, and tellurium. And those writers inform us—

That the list of organic compounds is almost endless, and is rapidly extending; that it is an interesting question how, from three or four elements, such a multitude of substances, with so infinite a diversity of properties, can arise; that a compound body is formed by the union of one, two, or more simple bodies; a compound of one simple with another simple body is called a BINARY compound; a TERNARY contains three, and a QUATERNARY four elements; a combination of a body with oxygen, is called an OXIDE; with chlorine, a CHLORIDE; with sulphur, a SULPHURET, etc.

That the conversion of a fluid, or gaseous body, into the state of a solid, is termed CRYSTALLIZATION; that all bodies, which can become fluid or gaseous, without losing their chemical properties, can be crystallized.

That the metals form the largest division of the chemical elements, and occur in nature in three states; some of them, as gold, silver, platinum, and mercury, being often found uncombined; that mercury vaporizes at 662°, and several metals are so volatile that they may be distilled from their compounds; even gold is dissipated in vapor in the focus of a powerful burning-glass; that salts result from the union of non-metallic elements with the metals; they are therefore to be considered as compounds of the metals.

That chlorine is never found free in nature, but exists abundantly in the mineral world, chiefly in combination with the metal sodium, as common salt; that chlorine is one of the most energetic of the elements, surpassing even oxygen under some circumstances; that owing to the active character of chlorine, it forms compounds with nearly all the elements. That bromine is the only element, except mercury, which exists as a liquid at ordinary temperatures. That iodine exists in mineral springs, and has also been found in minute quantity in certain minerals. That fluorine is a volatile and highly corrosive fluid; the hardest substances, even glass, may be dissolved by its action. That sulphur, selenium, tellurium, and phosphorus, are closely allied to each other and marked by their strong attraction for oxygen; that the part played by phosphorus in the scheme of nature is of the highest interest; existing, combined with lime, in certain rocks, by their gradual decay in the course of ages it passes into the soil; that phosphorus combines with chlorine so energetically as to take fire, and forms numerous compounds with iodine, bromine, nitrogen, and sulphur.

Aluminum is the metallic basis of pure clay; calcium is the basis of lime, and if to these we add silicon, we have before us the three elements which constitute the basis of by far the largest portion of the solid crust of the earth. By bringing together simple gaseous elements, we can form binary compounds, and these, with the water of crystallization, will unite and form solid crystalline bodies, and of such the mountains of the earth are formed. These crystal compounds can be decomposed and resolved into their simple gaseous elements; and therefore, to form a solid world from gaseous matter, and to resolve it again into its ultimate gaseous elements, it is necessary that attraction and repulsion, each alternately predominating, should exert their composing and decomposing energies upon a more extended scale and throughout a longer period of time. The chemist can compose and decompose with astonishing precision the various elements upon which he operates, but he cannot approach the intricate and wonderful processes of nature as exemplified in the animal, vegetable, and mineral kingdoms. The great bulk of the matter which sustains the vegetable creation passes through the atmosphere, for the moisture which is absorbed by the root is carried up by the ocean, and laborated in the atmosphere by the action of the sun. Rain water is the appropriate drink of vegetables, and they live and grow by transforming a portion of this liquid and secreting it in conjunction with other matter derived from the atmosphere, so that the same matter which in early spring-time exists in the ocean in the form of water, may be found in autumn secreted in the vegetable kingdom and existing in the solid form. Metallic bases have been obtained in the analyses of plants, whose nutriment has been derived exclusively from the atmosphere. "The life of plants," says Professor Liebig, "is closely connected with that of animals, in a most simple manner, and for a wise and sublime purpose. The presence of a rich and luxuriant vegetation may be conceived without the concurrence of animal life, but the existence of animals is undoubtedly dependent upon the life and development of plants." . . . The experiments of De Saussure have proved that the upper strata of the air contain more carbonic acid than the lower, which are in contact with plants; and that the quantity is greater by night than by day, when it undergoes decomposition. Plants thus improve the air, by the removal of carbonic acid, and by the renewal of oxygen, which is immediately applied to the use of man and animals. The horizontal currents of the atmosphere bring with them as much as they carry away, and the interchange of air between the upper and lower strata, which their difference of temperature causes, is extremely trifling when compared with the horizontal movements of the winds. Vegetable culture heightens the healthy state of a country, and a previously healthy country would be rendered quite uninhabitable by the cessation of all cultivation.

By chemical motion matter expands into a greater or contracts into a lesser volume, as when a cubic inch of gunpowder is exploded, and thereby expanded into a volume of gas of many hundred cubic inches; or when 2,000 cubic inches of oxygen and hydrogen gases, in the proper proportions, are exploded and thereby contracted into one cubic inch of water. Oxygen and nitrogen, in combination and simple mixture, constitute almost the entire atmosphere which surrounds the globe. Oxygen and hydrogen form the water of the rivers, lakes, seas, and ocean; and of that of the salt sea chlorine forms no inconsiderable portion. When we examine the solid rocks of the earth, we find the same elements in combination chiefly with metals, for the solid earth is little else than a metallic oxyd.

When solid bodies are to be decomposed, their parts are first separated from each other by the mechanical operation of pounding in a mortar or otherwise, and in many cases they are further separated by solution; after which the dissolved materials are subjected to a certain degree of heat, and they are decomposed into their ultimate elements. Such is the ordinary process by which chemical decomposition is effected. But the most powerful instrument yet discovered for effecting chemical decomposition is the Voltaic pile or Galvanic battery. When this battery is sufficiently powerful, the repulsive and attractive forces are brought so strongly into play, that every substance yields to its decomposing effects—air, water, metals, earths, and even flints are dissolved by this mysterious agency, in short, every substance; so that with a battery of sufficient magnitude and power, the entire earth might be dissolved and passed off in the form of vapor or invisible gas. Crystals are the hardest or most contracted of all bodies; gases are the softest or most expanded, and the galvanic battery has, within itself, the power, when acting on appropriate matter, to transform it into either of these states—to carry the opposite processes onward to the two ultimate points of expansion and contraction, and these powers appertain to it, because in the process the forces of attraction and repulsion are brought into active collision with each other, and as the one or the other force predominates, so does the process tend to one or the other ultimate point. These powers, guided by the Creator, which can form and dissolve a single crystal in a few months, can also form and dissolve a world. There is no distinction between the one or the other process, except in the magnitude of the operation, in respect to the latter, and the time required for its accomplishment; and when we reflect that eternity is the time allotted to nature for carrying out vast purposes, we cease to doubt or even to wonder that results so great as the formation or dissolvation of that which, to our limited view, appears to be an immense solid globe of matter, should be brought about by the slow and silent operations of two invisible forces.

Carbon forms the basis of the organic world—that is, of the vegetable and animal kingdoms. It also exists to a considerable extent in beds of coal. In combination with oxygen it enters into the composition of chalk, limestones, and more or less into that of almost every rock composing the solid crust of the earth. In combination with hydrogen it constitutes the common coal gas with which our cities are illuminated. Carbonic acid gas consists of one equivalent of carbon united with two of oxygen. It is an important gaseous compound, the formation and decomposition of which is constantly going on in nature upon a very extensive scale. It is the product of combustion, and is fatal to flame and to animal life. Carbon and oxygen enter into combination with an energetic action, of which heat and light are accompanying effects. The action which accompanies the formation of carbonic acid is a portion of that congeries of actions and re-actions which we call animal life.

In every case action of some kind is necessary to the production of heat. Dr. Franklin says, "that the electric fire, though it has no sensible heat when in a state of rest, will, by its violent motion, and the resistance it meets with, produce heat in other bodies when passing through them, provided they be small enough. A large quantity will pass through a large wire without producing any sensible heat; when the same quantity, passing through a very small one, being there confined to a narrower passage, the particles crowding closer together and meeting with greater resistance, will make it red-hot, and even melt it. . . . When trees or houses are set on fire by the dreadful quantity which a cloud, or the earth, sometimes discharges, must not the heat, by which the wood is first kindled, be generated by the lightning's violent motion, through the resisting combustible matter ?"

Oxygen and hydrogen have a powerful affinity for each other, and in the act of their combining the most intense heat and light are exhibited. If one part of hydrogen gas be mixed with eight of oxygen, and the electrical spark passed through the mixture, the whole of the two gases will combine chemically, and water will be formed. These two substances, as well as every other, will combine in definite proportions only. Hydrogen is the most expanded or lightest of known bodies; its formation is continually going on upon the earth's surface, and it ascends to the higher regions of the atmosphere. "The atmosphere," says Professor Liebig, "is composed of four-fifths nitrogen and one-fifth oxygen—not, however, chemically united; it also contains a ten thousandth part of carbonic acid and watery vapor. A mixture of oxygen and nitrogen, in the proportions named, exhibits the general properties of the atmosphere." The atmosphere is the name of the accumulation, while the air is the name of the substance, but we may use either term as expressive both of the mass or volume of the air and of its substance. The quantity of the atmospheric fluid has been estimated to be five hundred and thirty-two billions of tons.

We assume that light and heat do not come directly from the sun, but are produced in the atmosphere of the earth, where a silent and feeble combustion upon a most extensive scale is continually going on by day; that is, while the sun is above the horizon, while the solar gas which issues from the sun is penetrating the earth's atmosphere, and exciting that chemical action whereby heat and light are given out, as in the combination of oxygen and hydrogen. We are not authorized to infer that nitrogen is an active agent, although forming a large proportion of the atmosphere, in the production of that light and heat which we contend is produced in the earth's atmosphere by a process analogous to combustion.

According to the corpuscular theory of solar light, an extremely subtle and LUMINOUS fluid is continually issuing from the sun; but in such a case there could be no darkness on the earth at any period of the twenty-four hours, for although the sun would be invisible still the solar system would give light upon that side of the earth turned from the sun. When the moon is totally eclipsed, she is not entirely darkened, but still reflects a dark-red light, which comes not directly from the sun, for the earth is interposed between the two bodies—nor from the earth, for the dark side of this body is presented to the moon.

But the undulatory theory of solar light is now the popular one; according to which there is NO EMANATION from the sun, but the ethereal fluid pervading space is excited and set into a vibratory movement like the rising or falling of a wave upon the surface of the ocean, and the fluid does not move out of its place, but merely vibrates in consequence of the excitement of the sun. Light produced in such a manner, without the expenditure of matter, would be an anomaly in nature, for even in the production of electrical light there is the evident passage of a material substance.

Now, if we adopt the hypothesis of a non-luminous fluid or gas issuing from the sun, entering into chemical combination with another gas also non-luminous, in the earth's atmosphere, light and heat being given out as effects of that action, or weak and extended combustion, of which nitrogen is the product, and this again being essential to the support of the vegetation of the earth—if we view the matter in this light, we shall find everything consistent and in strict analogy with all the known processes going forward in nature. We shall perceive that the planets ought to shine with a brilliant light, because the light is generated in the atmosphere of each, and the different colors which they exhibit are to be attributed to the different qualities of the gaseous atmospheres by which they are surrounded. By taking this view of the subject, we may infer that the pale silver light of the moon is owing to a great deficiency of atmosphere, and consequently that the action of the solar fluid upon it is much less intense. And we shall further perceive, that it by no means follows that the distant planets should be either cold or deficient in light, at least in the ratio generally laid down, since the light and heat is not derived directly from the sun, but is produced in the body. And although the quantity of the solar fluid must diminish as the distance from the sun is increased, yet this may be, to a great extent, compensated by the internal activity of the body itself. This production of light in the earth's atmosphere, in the manner here intimated, is perfectly analogous to that given at the galvanic battery, by two currents of electricity entering into combination or neutralizing each other, or to the combination of oxygen and hydrogen, or metal with oxygen, or any other case of chemical union where two active elements combine and form an inactive or neutral compound.

The processes of vegetation upon the earth, and even the rotation of the earth upon her axis, to which we shall again refer, are each of them connected with and dependent upon the continued action excited by the solar non-luminous gas. Indeed, all the terrestrial circuits of motion are actuated by the great circuit of the solar system, and the solar gas is a portion of that circuit.

It may be affirmed that the currus, cumulus, stratus, and the intermediate clouds, are nothing more than vegetable food in various stages of the process of preparation. Beginning with the elaboration of vegetable food in the atmosphere, as manifested in the formation of clouds, the contents of which are subsequently scattered over the surface of the earth, and following the chain of the process downward, we shall ultimately reach the formation of solid rocks in the mineral kingdom by an easy and natural gradation. All the matter in the atmosphere exists in the gaseous form, or at least must have been in the expanded or gaseous state, or otherwise it could not have ascended into the higher regions of the air; but instead of remaining permanently in that state, there is a preparation for its return to the earth going on. It is again contracted, and in this contraction atmospheric electricity evidently plays an important part, as witnessed in a thunder-storm, which is almost uniformly followed by the descent of a vast body of water or matter, which has been suddenly contracted from its previous expanded or gaseous state. The electro-chemical process in the atmosphere is constant. The solid vegetable matter formed every year upon the surface of the earth is devoured by the animal kingdom, which depends upon the vegetable kingdom for support, as the vegetable kingdom depends upon the atmosphere. If we trace the matter from the atmosphere into the vegetable, the change is so striking, the transformation so complete, that we can no longer recognize the same matter, and yet no fact is more firmly authenticated than that the previously gaseous matter of the atmosphere has become solid vegetable substance; so likewise in respect to the next transformation of vegetable into animal matter. A bushel of grain is not a pound of flesh, neither can any act of the chemist transform the one into the other, and yet we know from every day's experience that such transformation takes place by the chemistry of nature. If we trace the process onward, from the atmosphere to the vegetable kingdom, from the vegetable kingdom to the animal kingdom, and from the animal kingdom to the mineral kingdom, in the formation of vegetable mold, by the worms existing in the soil, we shall be amazed by each and all of the transformations, for all are equally wonderful; and although chemical science fails to unravel the mystery, still the fact of such transformation is plainly manifested before our eyes. The great process by which the world is being transformed into solid rock does not come to a state of rest at any point. As a general law, the oldest rocks within the earth are the most contracted; but it is demonstrated, by the vegetable remains entombed within them, that these rocks once formed a portion of the earth's surface, or the surface of a satellite attending the earth.

SECTION III.

DEDUCTIONS FROM GEOLOGY.

It has been beautifully remarked, that "if astronomy has discovered that the heavens declare the glory of God, as certainly are we assured by geology, that the earth showeth his handiwork."

"All are aware," says Sir Charles Lyell, "that the solid parts of the earth consist of distinct substances, such as clay, chalk, sand, limestone, coal, slate, granite, and the like; but previously to observation it is commonly imagined that all these had remained from the first in the state in which we now see them—that they were created in their present form, and in their present position. Geologists have come to a different conclusion. They have discovered proofs that the external parts of the earth were not all produced in the beginning of things, in the state in which we now behold them, nor in an instant of time. On the contrary, they have acquired their present configuration and condition gradually, under a great variety of circumstances, and at successive periods, during each of which distinct races of living beings have flourished on the land and in the waters, the remains of these creatures still lying buried in the crust of the earth.

"By the earth's crust is meant that small portion of the exterior of our planet which is accessible to human observation, or on which we are enabled to reason by observations made at or near the surface. These reasonings may extend to a depth of several miles, perhaps ten miles. . . .

"Now the materials of this crust are not thrown together confusedly, but distinct mineral masses, called rocks, are found to occupy definite spaces, and to exhibit a certain order of arrangement. The term rock is applied indifferently by geologists to all the substances, whether they be soft or stony, for clay and sand are included in the term, and some have even brought peat under this denomination. . . .

"There are four great classes of rocks considered in reference to their origin—the aqueous, the volcanic, the plutonic, and the metamorphic. . . . Portions of each of these four distinct classes have originated at many successive periods. They have all been produced contemporaneously, and may even now be in the progress of formation. . . .

"The aqueous rocks, sometimes called the sedimentary, or fossiliferous, cover a larger part of the earth's surface than any others. These rocks are stratified, or divided into distinct layers, or strata. . . . The volcanic rocks are for the most part unstratified, and are devoid of fossil. . . . All the various kinds of granite, which constitute the plutonic family, are supposed to be of igneous origin, but to have been formed under enormous pressure, and at considerable depths in the earth. . . . The fourth and last great division of rocks is the crystalline strata, and slates, or schists, called gneiss, mica-schist, clay-slate, chlorite-schist, marble, and the like. . . .

"The ordinary materials of which the stratified and fossiliferous rocks are composed may be said to belong principally to three divisions, the arenaceous, the argillaceous and the calcareous, which are formed respectively of sand, clay, and carbonate of lime. Of these, the arenaceous, or sandy masses, are chiefly made up of siliceous or flinty grains; the argillaceous, or clayey, of a mixture of siliceous matter, with a certain proportion, about a fourth in weight, of aluminous earth; and lastly, the calcareous rocks or limestones consist of carbonate of lime."

Geologists divide the different strata which compose the earth's crust into ages and periods, in their order of succession, as thus indicated:

MAMMALIAN AGE: Post-tertiary, and Tertiary periods.

REPTILIAN AGE: Cretaceous, Jurassic, and Triassic periods.

CARBONIFEROUS AGE: Permian, Carboniferous and Sub-carboniferous periods.

DEVONIAN AGE, OR AGE OF FISHES: Catskill, Chemung, Hamilton, Corniferous, and Oriskany periods.

SILURIAN AGE, OR AGE OF MOLLUSKS: Lower Helderberg, Salina, Niagara, Hudson, Trenton, and Potsdam periods.

Some geologists have adopted the following groups of fossiliferous strata observed in Western Europe, beginning with the newest:

TERTIARY: 1. Post-Pliocene, including those of the recent, or human period. 2. Newer Pliocene. 3. Older Pliocene. 4. Miocene. 5. Eocene.

SECONDARY: 6. Chalk. 7. Greensand. 8. Wealden. 9. Upper Oolite. 10. Middle Oolite. 12. Lias. 13. Upper New Red Sandstone and Muschelkalk. 14. Lower New Red and Magnesian limestone. 15. Coal. 16. Old Red Sandstone and Devonian.

PRIMARY FOSSILIFEROUS: 17. Upper Silurian. 18. Lower Silurian. 19. Cambrian and older fossiliferous strata.

Granite is composed of crystalline materials—crystals of quartz, felspar, and mica. De La Beche gives the composition of granite as follows: "Silica, 74, 84; alumina, 12, 80; potash, 7, 48; magnesia, 0, 99; lime, 0, 37; oxyd of iron, 1, 93; oxyd of magnesia, 0, 12; fluoric acid, 0, 21." All the rocks of the earth, stratified and unstratified, may be said to be composed of similar materials. The principal difference appears to consist in the mineral structure or internal arrangement of the constituent elements of which the rocks are composed. Of the internal constitution of the globe we know comparatively little or nothing; but the range of geological inquiry is extended over a wide field, embracing the history of the planet which we inhabit for millions of years previous to its occupation by the human race.

"There was a time," says Hugh Miller, "when life, animal, or vegetable, did not exist on our planet, and when all creation, from its centre to its circumference, was but a creation of dead matter. Every plant and animal that now lives upon earth began to be during the great Tertiary period, and had no place among the plants and animals of the great Secondary division.

"Not until we reach the times of the Tertiary division do the mammals in their higher orders appear. The great Tertiary volume corresponds to those volumes of Cuvier, which treat of the placental animals that suckle their young. And finally, last born of creation, man appears upon the scene, in his several races and varieties. . . .

"No insects have yet been detected in the Silurian or Old Red Sandstone systems. They first appear amid the hard, dry, flowerless vegetation of the Coal Measures, and in genera suited to its character. . . . . In the Oolitic ages, however, insects become greatly more numerous, so numerous that they seem to have formed almost exclusively the food of the earliest mammals, and apparently, also, of some of the flying reptiles of the time."

In reference to the origin of the rocks which now constitute the solid crust of the earth, in whichever way we turn we meet with an insuperable difficulty from which there is no escape; but by considering that the list of chemical elements, commonly believed to be simple substances, are not, in fact, elementary, but that, by that mysterious process called vital action in the vegetable, animal, and mineral kingdoms, every substance becomes so modified and changed, that after having passed through a chain of processes, as vegetable, animal, and mineral, with the intermediate links, it appears to our apprehension to consist of a combination of entirely new elements.

If we find that by the vital action of the vegetable and animal kingdoms liquid matter is continually being transformed into solid matter, both upon the earth and in the ocean; that the stratified rocks contain within themselves evidence that they also have been formed in a like manner; and that a specific process, a vital action, is also going on in the mineral or crystalline kingdoms, we have before us the chief links of that chain of process by which a globe, originally liquid, has been for millions of years and is now passing onward to the state of a solid world. There is nothing unphilosophical in the assumption, that the time will arrive when the entire globe will be nothing else than one huge crystalline mass, penetrated in every direction by rich metallic veins. The metal will be abundant in the earth, but there will be no human beings to dispute about the possession.

In one of his poems, "The Last Man," Campbell says:

"I saw a vision in my sleep,
That gave my spirit strength to sweep
Adown the gulf of Time!
I saw the last of human mold
That shall Creation's death behold,
As Adam saw her prime.
The sun's eye had a sickly glare,
The Earth with age was wan,
The skeletons of nations were
Around that lonely man!
Some had expired in fight—the brands
Still rusted in their bony hands,
In plague and famine some!
Earth's cities had no sound nor tread;
And ships were drifting with the dead
To shores where all was dumb!"

There are few propositions in natural philosophy more firmly and indubitably established than that this planet which we inhabit had a beginning. "The Mosaic narrative commences with a declaration, that 'In the beginning God created the heaven and the earth.' These few first words of Genesis may be fairly appealed to by the geologist, as containing a brief statement of the creation of the material elements at a time distinctly preceding the operations of the first day. It is nowhere affirmed that God created the heaven and the earth in the FIRST DAY, but in the BE-

GINNING; this beginning may have been an epoch at an unmeasured distance, followed by periods of undefined duration, during which all the physical operations disclosed by geology were going on. . . . . Millions of millions of years may have occupied the indefinite interval between the beginning in which God created the heaven and the earth, and the evening or commencement of the first day of the Mosaic narrative."

Geology has established the fact, that through a long series of ages a slow and silent progression has been going forward in the vegetable, animal, and mineral kingdoms, and the earth being a finite quantity this progression must have had a beginning. Whole races of vegetables and animals have passed away and are no more. "From the remotest periods there has been ever a coming in of new organic forms, and an extinction of those which pre-existed on the earth; some species having endured for a longer, others for a shorter time; while none have ever reappeared after once dying out. The law which has governed the creation and extinction of species may thus be expressed—'Nature made it and then broke the die.'" The specific circumstances favorable to the existence of each of the bygone races, have ceased upon the earth, and can never again occur until the solid rocks in which are entombed the remains of former races shall have been dissolved and dissipated in the gaseous form;

this gaseous matter will then give rise to new aggregations of cometary and planetary masses, in which again will be called into play all the active circumstances which prevailed in the remotest period of the earth's planetary existence. If this formerly fluid world contain at this time immense masses of solid rocks, they have been formed during the lapse of ages, and the process is still going on; and as certainly as the earth is a finite quantity this process must come to a termination.

The formation of new islands constitutes a distinct and interesting class among the changes to which the surface of the globe is subject. Those which have been raised up by volcanic agency are comparatively few; but those of coral, which owe their origin to marine insects, are very many. The shores and shoals of the Red Sea are encircled by rocks of coral. "The examination of a coral reef, during the different stages of one tide," says Captain Bazil Hall, "is particularly interesting. When the tide has left it for some time, it becomes dry and appears to be a compact rock, exceedingly hard and rugged; but when the tide rises and the waves begin to wash over it, the coral worms protrude themselves from holes which were before invisible; when the coral is broken about high water mark, it is a solid hard stone; but if any part of it be detached at a spot which the tide reaches every day, it is found to be full of worms of different lengths and colors." The growth of coral appears to cease when the worm is no longer exposed to the washing of the sea. "When the animalcules which form the coral at the bottom of the ocean cease to live, their structures adhere to each other, and the interstices being gradually filled up with sand and broken pieces of coral, washed by the sea, which also adhere, a mass of rock is at length formed. Future races of these animalcules erect their habitations upon the rising bank, and die in their turn, to increase, but principally to elevate this monument of their wonderful labors. The coral, sand, and other broken remnants, thrown up by the sea, adhere to the rock and form a solid mass with it, as high as the common tides reach. The new bank is not long in being visited by sea-birds; plants take root upon it, and a soil begins to be formed; a cocoa-nut, or a drop of pandamus is thrown on shore; land-birds visit it and deposit the seeds of shrubs and trees; every high tide, and still more every gale adds something to the bank; the form of an island is gradually assumed, and last of all comes man to take possession."

Here we have nearly all the conditions required for the formation of the successive beds of which the stratified crust of the earth is composed. First, the formation of a limestone rock in the sea, in which we may reasonably expect to find the remains of marine animals and plants. Second, the commencement of vegetation and the formation of vegetable soil. All the active processes of the vegetable and animal kingdoms are brought into play, by which, in process of time, the formation of a bed containing the remains of terrestrial animals and plants may be reasonably anticipated. In order to obtain a succession of these beds alternating with each other, it is required that the surface shall be covered by the ocean during the period of the marine deposit, and laid bare to the action of the sun, the rain, and the atmosphere, during the period of the terrestrial formation. In order to obtain these alternations in the relative levels of the sea and land, it is necessary either that the surface of solid earth shall be raised and lowered alternately, or that the level of the sea shall be raised and depressed in a manner analogous to that which takes place daily in the ordinary tides.

M. Elie De Beaumont, from the most careful and extensive observations, has come to the conclusion, "That in the history of the earth there have been long periods of comparative repose, during which the deposition of sedimentary matter has gone on in regular continuity; and there have also been short periods of paroxysmal violence, during which that continuity was broken. At each of these periods of violence or revolution, in the state of the earth's surface, a great number of mountain chains have been formed suddenly. Each revolution, or, as it is sometimes termed, frightful convulsion, has fallen in with the date of another geological phenomenon, namely, the passage from one independent sedimentary formation to another, characterized by a considerable difference in organic types. There has been a recurrence of these paroxysmal movements from the remotest geological periods, and they may still be reproduced. The successive revolutions, above mentioned, cannot be referred to ordinary volcanic forces, but may depend on the secular refrigeration of the heated interior of our planet."

Strong arguments have been advanced in support of the common conclusion, that the mountain ranges of the earth have been upheaved by a force acting from beneath; but if they have, then all the great elevations of the surface ought to be found near the poles where the crust of the globe is the thinnest; but they are all within or near the tropics where we should expect to find them, if we suppose them to be the remains of a deposited satellite, which has subsequently been broken up by the earth's rotation and other causes, and scattered over the surface; they are exactly beneath the moon's orbit, and the moon is at this moment approaching the earth. The satellites of all the other planets also move in orbits whose axes are nearly coincident with that of their respective primaries, and, therefore, we are justified in supposing, that if at a former period the earth was attended by several satellites, their orbits were nearly coincident with that of the remaining moon.

Now, there is good presumptive evidence that, at an early period of the earth's planetary existence she was attended by four, or more moons, and that her upper strata are principally composed of the wrecks of the first four, which have been precipitated upon her surface at different and indefinite remote periods of time. The remaining moon is a much smaller body than the earth; consequently, if like the earth, she has been passing into the solid condition through a long succession of ages, we should expect that, being the smaller of the two bodies, the process would be nearer to completion; and this is precisely what we do find. Her ocean is nearly dried up, and she is almost devoid of an atmosphere. The process—the internal action is nearly complete. She has been the repository of vegetable and animal life, like the earth, and so long as there is moisture to nourish the vegetation, life of some sort, both animal and vegetable, will continue. When that process is finished she will become a dead mass of rock; her course will be finished; she will have fulfilled her purpose, and, falling upon the primary earth, like her predecessors, the matter will be conveyed with the earth to the central sun, there to be dissolved; again to issue to form a new world in which all will be life and activity.

Geologists generally attempt to explain the various appearances exhibited in the earth's crust, by alternate elevations and depressions of the land, overlooking the plain and manifest rule which obtains throughout the works of nature; namely, that in every case the simplest means and modes of action are employed to accomplish the end. Which is the easier, more simple, more natural—to raise and depress the level of the liquid ocean so as to cover and uncover different portions of the solid earth at different times, or to elevate and depress the solid rocks so as to accommodate themselves to the liquid ocean? That both of these modes of operation have been employed there cannot be a doubt; but there is good reason to conclude that the elevation and depression of the ocean has been the rule; that of the solid earth the exception.

What would be the effects consequent upon the shifting of the great mass of the waters of the ocean? If we cast our eye over the map of the globe, we perceive that the southern hemisphere is to a large extent covered by the South Sea, and, *vice versa*, that the greater portion of the exposed surface or dry land is situated in the northern temperate zone. We are well assured that limestone rocks are not at present forming on the dry land of the northern hemisphere; at the same time we have evidence that such deposits are now in the process of formation in the South Sea. If by any means the conditions of the two opposite hemispheres could be reversed—the northern covered with the ocean, and the southern laid bare to the atmosphere, it is plain that, according to the ordinary processes of nature, we should have the formation of limestone going on in the northern, and of terrestrial deposits in the southern hemisphere; and the thickness of the respective beds, or quantity of matter deposited, would bear some proportion to the time during which the supposed conditions remained unchanged.

Now, the aphelion and perihelion points of the earth's orbit are not fixed. These points have a progressive motion in space, so slow that about 114,000 years are required to complete one entire cycle; that is, to bring the two points into the same relative positions, with respect to the fixed stars, as at the commencement. Therefore, as the earth's axis never changes its position, in respect to the stars, at the end of a period of 57,000 years from now, the north pole of the earth will be presented to the sun, while the earth is in the perihelion point; and, therefore, the great body of the waters will be drawn around and cover the land of the northern hemisphere—the southern hemisphere being at the same time laid bare to the action of the sun and atmosphere. If such be the course of events, the alternate deposition of marine and terrestrial beds will admit of an easy and natural explication, without doing violence to the laws of nature, by sinking and upheaving continents in order to bring the observed facts to coincide with our preconceived hypothesis. The geological sections of the stratified rocks, whose formation might be referred to the ebbing and flowing of the ocean alternately in the northern and southern hemispheres, are numerous.

If we dig through the vegetable soil which composes the surface, we come generally to beds of gravel, or clay, or chalks, or other rock, according to the nature of the country in the locality in which we dig. Of these substrata, gravel is the most common. These beds of gravel consist of coarse sand, rolled pebbles, and large stones, with occasionally huge blocks, termed BOULDERS. The various stones have evidently been rolled in water, and consequently undergone a process of rubbing against each other. We have, then, to look for some natural combination of circumstances by which this rubbing could have been effected. If we look to brooks, rivers, and the ocean, we perceive the process now in active operation. We have abundant reason to conclude that these beds of gravel once formed the bed of the ocean. Either the surface has been upheaved from the bottom of the deep, or the sea has retired into the southern hemisphere, where the mass of the waters constitute that which is at present the great South Sea. We adopt the latter conclusion as being more consistent with the usual operations of nature.

On the Whittle Hills, near Preston, Lancashire, 300 feet above the level of the sea, are found beds of marl, sand, and gravel—under the ordinary diluvium, with erratic blocks or boulders—which are full of shells of molluscous animals of the race now living in the adjoining sea. On Moel Tryvaen, deposits of marine shells, and also granite boulders, are seen 1,000 feet above the present sea level. At Holderness, in Yorkshire; Murray Frith, in Scotland; Wexford, in Ireland; St. Michael, in France; also in Sicily, Greece, and in Asia Minor, indeed generally along the sea coasts of Europe, the same phenomena may be observed. In the Baltic, at Lofgrundet, near Upsula, observations have been made by which it has been determined that the change of level in that locality is about three feet in a century. During that period either the land has been upheaved or the level of the sea has been lowered. These deposits are found in every situation, not on the coasts only, but at a great distance inland in Central Asia, and in America, as well as other countries. A phenomenon so general must be attributed to a general cause; and M. Brongniart considers it to be the recession of the water, leaving the land uncovered, with marine shells in the place and condition in which they are deposited.

On this hypothesis everything becomes harmonious. The undulating hill and valley surface of any country in the world has no abrupt precipices, except in some localities where the intermediate cause can be seen. The general aspect of the country is such as might be expected to result from the long continued action and agitation of an immense superincumbent mass of water. Seeing that the beds of gravel and other superficial deposits could not have been formed by any of the physical causes now in action in the northern hemisphere, neither by atmospheric action, by rains, streams, nor rivers, we are compelled to admit that these northern countries once formed the ocean bed. The deposits, above referred to, are, as compared with the whole crust, a mere outward skin; and if their formation be due to the alternate shifting of the ocean from the one to the other hemisphere as a consequence of the progression of the earth's aphelion point in the ecliptic, requiring for the completion of the cycle 114,000 years at the present time—and in former ages, when the earth was further from the sun, it must have required a still longer period—if in the formation of the merely external alluvial deposits, a few yards in thickness, a period of 114,000 years has elapsed, and if the whole of the stratified rocks, which, taken together, form, according to Dr. Buckland, a thickness of ten miles, HAD BEEN FORMED UPON THIS PLANET ONLY, and by an equally slow process, then it baffles our means of computation to ascertain the length of time that the earth has existed as a planet!

"Not only are gravels," says De La Beche, "brought from various distances, but even huge blocks, the transport of which, by actual causes into their present situations, seems physically improbable." From the manner in which they are thrown together it is evident that they were not quietly deposited, but by some violent concussion or catastrophe. The cause of these effects must be sought for WITHOUT the earth and within the solar system.

The aggregate thickness of the tertiary deposits in some places amounts to several thousand feet. The strata are more or less disturbed. At Alum Bay, in the Isle of Wight, the beds are in a vertical position resting upon an UNBROKEN bed of chalk. If the rocks found in such circumstances—that is, set upon their edges could not have been disturbed from beneath, is it to be assumed that they were derived from the detritus of the secondary rocks? We say no, for the mineral composition of the vertical rocks is different from that of the secondary; and the gypsum beds of the tertiary system contain the fossil remains of animals of a species wholly distinct from any which lived upon the earth previous to the deposition of the tertiary strata, and also unlike any species living upon the earth at the present day.

To have produced disturbances upon the scale exhibited in the different mountain ranges, by igneous action, would have required that the whole earth should be nothing less than one huge raging volcano.

Nor could some disturbances noticed in the earth's crust have been effected even upon such an hypothesis. Inclined strata resting upon an unbroken horizontal foundation must have been deposited from above, in the solid form, and in a mass.

As the formation of solid rocks has been going on in the earth for ages, we have a right to infer that a similar process is and has been going on in the moon, and that the rocks formed in each of the bodies are, in their mineral composition, to a certain extent analogous. The primaries and satellites are similarly situated in the solar system, with respect to the sun's influence, and other circumstances affecting the vital action of the vegetable, animal, and mineral kingdoms. Even if two rocks present some characteristics analogous in respect to their mineral composition, that circumstance alone does not enable us to determine that both rocks were formed upon the primary earth. One may have been formed upon an attendant satellite, and yet both rocks may be similar in their mineral composition. And there is nothing in the mere similarity of the tertiary fossils to the existing species which warrants the conclusion that they must have lived upon this earth, since all the conditions necessary to their existence might have been equally found in a satellite attending the earth.

Baron Cuvier remarked, "That without fossil geology there was no true geology." By the study of fossil remains, that which was before a high probability becomes an absolute certainty. The past history of the earth, as traced by the finger of science upon the mountains and rocks of the globe itself, is indeed a strange and marvelous history to those who have never given their attention to the subject. It is full of wonder, but it is also full of truth. At Monte Bolca immense numbers of fossil fishes have been found huddled together in such a manner that it is evidently impossible they could have lived in the locality in which they are found. A violent concussion must have destroyed them instantaneously. They are found entire, the fleshy parts not decomposed, as they would have been had they died in the usual course.

Of the animals and vegetables, whose fossil remains are found in the Secondary strata, the species and even the genera have ceased to exist, and this did not take place by graduated steps, but suddenly and at once. "The group which succeeds to the tertiary strata in the descending order has been called Cretaceous or chalky, because it consists in part of that remarkable white earthy limestone chalk. With this limestone, however, are usually associated other deposits of sand, marl, and clay, called the Greensand formation, because some of its sands are remarkable for their bright green color. The white chalk used in writing consists almost purely of carbonate of lime. Although usually soft, this substance passes in some districts, by a gradual change, into a solid stone used for building. Beneath the cretaceous rocks, in the southeast of England, a fresh-water formation is found called the Wealden, which, although it occupies a small area in Europe, as compared to the chalk, is nevertheless of great interest, as being intercalated between two marine formations. It is composed of three minor groups, Weald clay, Hastings sand, and Purbeck beds, of which the aggregate thickness in some places cannot be less than 800 feet."

The disturbances of the chalk group have been in some places upon the great scale. At the quarry of Weinbohla, on the Danube, a granite or syenite rock rests upon a horizontal bed of chalk; and on the Pyrenees the chalk is associated with granite and serpentine, pierced with mineral veins. In the valley of Kingsclerc, in Berkshire, England, two miles of solid chalk have been scooped out. That the strata were once continuous but subsequently broken by some cause will be granted. Geologists inform us that the matter was scooped out by the long-continued action of rivers and streams, and that it has gone toward the formation of the tertiary strata. If this process of breaking up one rock to form another had been the only resource which nature possessed whereby to form immense masses of stratified and unstratified rocks, a planet originally liquid would have remained so, and the natural progression of all terrestrial processes must have stood still. That the conglomerates and other mechanical rocks have been formed from the detritus of the old rocks may be safely admitted, but such admission cannot be made with respect to limestones and others of chemical origin. Neither the fossil remains nor the mineral composition of the tertiary strata bear out the conclusion that they have been formed from the wasted materials of the secondary rocks.

"When we examine the contact of the Purbeck beds, or inferior division of the Wealden, with the Portland stone, or upper member of the oolite, some very singular phenomena are observed. Between the two formations, the marine and the fresh-water, there intervenes, in Portland, a layer of dark matter, called by the quarrymen the Black Dirt, which appears evidently to have been an ancient vegetable soil. It is from twelve to eighteen inches thick, is of a dark brown or black color, and contains a large proportion of earthly lignite. Through it are dispersed rounded fragments of stone, from three to nine inches in diameter, in such numbers that it almost deserves the name of gravel. Many silicified trunks of coniferous trees, and the remains of plants allied to the Zamia and Cycas are buried in this dirt-bed." One conclusion respecting this bed may be relied upon, namely, that at the period in which the trees and plants grew and flourished, that part of the earth's surface was dry land; that this land was subsequently submerged, and that the submergence was effected somewhat suddenly.

In the lias of Lyme Regis the skin of animals, and the compressed contents of the intestines may be observed, which tends to show that the animals were suddenly destroyed and as suddenly preserved. When the upper part of the lias was deposited, multitudes of animals seem to have perished simultaneously, as is attested by a bed composed of little else, near Lyme Regis.

Dr. Buckland discovered some bones of a gigantic animal in the quarry of Stonesfield, near Woodstock, in Oxfordshire. They were examined by Cuvier who declared them to belong to an animal measuring forty feet in length, and having a bulk equal to that of an elephant seven feet high. A French philosopher remarked, that, "If the Almighty is great in great things, He is still more so in those which are minute." Vast quantities of animalcules, or infusoria, are found embedded in the earth. A cubic inch would contain about 41,000,000,000 of them. Their skeletons constitute nearly the whole mass of some soils and rocks, many feet in thickness, and extending over areas of several miles.

The Coal Measures embrace the carboniferous period. "The flora of the coal measures," says Hugh Miller, "was the richest and most luxuriant, in at least individual productions, with which the fossil botanist has formed any acquaintance. Never before or since did our planet bear so rank a vegetation as that of which the numerous coal seams and inflammable shales of the carboniferous period form but a portion of the remains. . . . The singularly profuse vegetation of the coal measures was, with all its wild luxuriance, of a resembling cast. So far as appears, neither flock nor herd could have lived on its greenest or richest plains, nor does even the flora of the oolite seem to have been in the least suited for the purposes of the shepherd or herdsman. Not until we enter on the tertiary periods do we find floras amid which man might have profitably labored as a dresser of gardens, a tiller of fields, or a keeper of flocks and herds."

A bed of coal is nothing else than a compressed mass of vegetable matter, which must have been produced upon the surface by the action of the solar and atmospheric influences. The matter has never, in this planet, at least, ministered to the action of animal life; it has passed onward as far as the circuit of motion of the vegetable kingdom, and there its progress has been arrested. The peat-bogs of Ireland, with similar land formations in other countries, enable us to come to some conclusion with respect to the manner of formation of the coal beds; bearing in mind that the temperature of the earth, the activity of vegetation, and several other circumstances are considerably changed since the period of the formation of coal beds. In a peat-bog we find a short brush of vegetation covering the surface. It is, however, in those parts only which are immediately exposed to the influence of the sun and atmosphere, that any signs of freshness are exhibited. The under portions which are secured from those influences appear dead, dried, and withered, are crumbling from the stem, falling upon and adding to the surface of the bog below. By these apparently humble means, great depths of peat-bog may be formed in the course of ages; this bog being buried up by some cause, and subjected to immense pressure for a series of ages, is converted into a seam of coal of considerable thickness.

The coal beds are land formations, for they consist of the remains of land plants; and it is clear that the associated limestones were formed in the bottom of the sea, for they contain marine shells in considerable quantity. While the coal beds were forming, it is evident that the surface was covered and uncovered many times, and during that long period no disturbance of the crust occurred. The Jarrow colliery, near Newcastle, shows that AFTER the formation of the whole series, a tremendous concussion was experienced, by which the whole was broken at once—not in one place only, but the entire mass has been shattered in a thousand places. The faults or lines of dislocation run continuously throughout the whole formation, proving that the concussion, whatever it was, acted at once. The lines of stratification correspond in every part of the broken mass, thereby proving that during the period of their formation no disturbance of any kind took place; so that, throughout a long period, in which a mass of rocks a thousand yards in thickness were forming, there was a state of repose on the earth such as we now witness. There is no force in this earth, of which we have any knowledge, competent to produce effects upon a scale so stupendous as that before us. If we would satisfactorily unravel the mystery we must turn to the heavens, bearing in mind our assumptions respecting the falling of satellites upon their primaries.

Mr. Greenhough, a practical geologist, says: "It is utterly impossible that the shell of the earth could have been broken and disturbed, as it evidently has been, by any force residing in the earth itself—a force capable of inundating continents, and giving to the waters of the deep unexampled impetuosity — and therefore, we must of necessity look for the cause of this disturbance to some other power external to the earth. . . . Moreover, the cause must be transitory, and one which, having acted its part once, may not have had occasion to repeat in the long period of five thousand years."

Nothing but the deposition and consequent breaking up of a satellite could fulfill the conditions here required. Now, the time which elapsed from the commencement of the deposition of the older secondary strata, to that of the most recent of the tertiary beds, appears to be divisible into four great botanico-geological periods, each of which being characterized by peculiar classes of plants, and each embracing a certain number of series of stratified rocks. There is between one period and another a marked division, a sudden change in the most important characters of the vegetation, and there exists no species common to two successive periods; all is different. The lowest strata of the first period in which animal remains are found, contain also those of plants. The red sandstones, which were deposited extensively at the second period, are more destitute of vegetable than they are of animal remains. The lowest stratum of the third period contains very few plants, and these chiefly marine; but they become more abundant in the sand, sandstones, clays, and limestones that succeed each other in numerous alternations up to the chalk. Many belong, however, to an entirely new race of plants from any which had previously existed. In the fourth period, from the termination of the deposit of the chalk formation, we discover in animal and vegetable remains the commencement of resemblances to species which now exist. There has been a general destruction of organized life at four distinct points, with a sudden and overwhelming force, accompanied apparently by a general deluge, and between each of these points a long period of repose intervening. What but the deposition of satellites unravels the mystery here involved?

It has been objected by some, that the whole of the secondary and tertiary strata of the earth would not furnish matter sufficient to form four satellites equal in size or volume to the moon. Now we do not assert that the planets are SOLID bodies; we assume that they are HOLLOW spheres, and that the external crust bears but a small proportion to the whole diameter; this assumption is consistent with the usual economy of nature. A little calculation will show us that the matter of the moon, even granting her to be a solid body, would fall very far short of filling up the present bed of the earth's ocean; whereas, if she be a hollow sphere, her whole matter would not, if deposited in the South Sea, form an island equal to Australia or New Holland. In whatever time she is precipitated upon the earth, the latter will receive a large accession of matter; a general deluge will take place, and in this nothing more will occur than the repetition of an event which we have reason to believe has taken place upon this earth four times already, and in a manner similar in every particular with that which is here anticipated.

Fossil plants have been found in the far north freezing latitude of Melville Island, in North America, which required for their growth a temperature so high that it is questionable whether they could be reared in the hottest part of the earth at the present day. This seems to militate with the opinion of the gradual approach of the earth to the sun. If heat and light came directly from the sun, the approach of the earth toward the heating body, with at the same time a decreasing temperature, would be a manifest paradox. Those sensible manifestations which we call solar heat and light are not emanations of luminous and calorific matter, for beyond the atmosphere of the earth and other planets, neither light nor heat can be discerned; that which we call solar light, is, more correctly, terrestrial light, for it is an effect of a specific action going on in the atmosphere of the earth; this light is, notwithstanding, indirectly derived from the sun, for the continuance of the atmospheric action is dependent upon a continuous supply of the solar fluid; and in every case the intensity of the heat and light is proportionate to the intensity of action; therefore, we conclude that at an early period, when the earth was YOUNG, less solid, more gaseous, the intensity of the terrestrial action was greater, and, as a consequence, the vegetation more luxuriant, notwithstanding the greater distance of the earth from the sun. In a child's body the circulation is rapid; the internal action is intense, and the temperature of the child is in the same proportion high. As age creeps on, the action, and, consequently, the temperature decreases; the circulation becomes languid; the gradual solidification of the animal organization, which has been going on from the first instant of its existence, as an independent being, is near its completion; the process must at length come to a termination. In this we see but a model of that which has been going on in the earth herself for ages—is now going on, and will continue for many ages yet to come.

SECTION IV.

DEDUCTIONS FROM ASTRONOMY.

The contemplation of the solar system and of the universe generally, by the harmony of its motions, by the beautifully regulated movements of its parts, affords pleasing satisfaction to the mind, and the knowledge we acquire in studying it is valuable, as leading us to an intimate acquaintance with the physical laws by which the operations of nature are governed.

"The earth both rotates on its axis and revolves about the sun, while around it circles a shining moon. The earth is not isolated, but is one of a brotherhood of planets, endowed with the same motions, and in many cases similarly attended. All these with myriads of comets constitute the solar system. Exploring further, we behold in the binary stars, suns revolving about each other with their respective trains of planets and comets, exhibiting the phenomenon of solar systems in motion. Piercing deeper into abysses of space stellar clusters and nebulæ stand forth revealed — objects of surprising grandeur and magnificence. For here suns crowd upon suns, forming a vast and numerous group of solar systems—united to all appearance by a common bond. Possibly these associated systems revolve about some mighty sun centrally situated within the radiant group; for if our solar system, together with the stars that glitter in our firmament, is really revolving around some central sun, analogy would lead us to infer, that similar motions also exist amid these starry clusters and nebulæ. Could we explore beyond the remotest nebulæ, through the successive realms of space, new scenes of grandeur would perpetually unfold; and new fields of Omniscient display would be constantly revealing that GOD was still before us in his creative energy, and that we saw but the 'hidings of His power.'"

There was a time when it was universally conceived that the earth was a fixed body placed in the centre, with the visible universe revolving round it; but at length the fact was established that she moved in an orbit with immense velocity. Then the question arose —How was she SUSTAINED in her orbit? Sir Isaac Newton showed that a body moving in a curved line, or circular path, must be under the action of a force acting in the centre or focus of that path or curve; and of a force acting at all times at right angles with the central force, the latter tending to urge the body onward in a direct line, and the former continually deflecting it from that right line, and thereby retaining it in its circular or curved path. These are the centripetal and centrifugal forces of the Newtonian philosophy. That the planets were held together by an invisible force it was evident, and this force was named attraction. The demonstration of the law by which the force of attraction operates inversely as the square of the distance, and the application of this law to the motions of the heavenly bodies, constitutes the great discovery of Sir Isaac Newton. A little reflection will enable us to discern that the momentum, or centrifugal force, as it is denominated, is no force whatever, but an effect derived from and dependent upon a real force—REPULSION. When a ball is discharged from a cannon's mouth, its momentum is derived from the explosion of the gunpowder, which, be it observed, is the expansive or repulsive force. If the momentum were a real force, like attraction, that could not be destroyed; it would move on forever, notwithstanding the action of an equal disturbing force, not in a right line, but in a curve, under the action of the two forces. It is impossible to comprehend or explain the motion of matter, unless we admit and introduce two natural forces; attraction is one of these, but momentum is not the other. Although momentum is incompetent to sustain a continuous effort against attraction, it must be taken as an adjunct, and allowance must be made for it as an effect entering into and in all cases modifying the subject of force and motion, more or less. The line of attraction is toward the centre, and it is evident that no force can completely counterbalance attraction except repulsion, whose line of action is toward the circumference. The moving body is at all times under the influence of the two opposing forces of attraction and repulsion; the stronger of these is the moving, the weaker is the regulating, power in each particular process. Motion and its accompaniment, momentum, are being continually originated, destroyed, and again originated, but the two forces which originate and annihilate motion and momentum are eternal and indestructible. If a body move with sufficient velocity it requires no solid support, just as a cannon ball is carried along by its momentum, without resting upon the solid earth ; this momentum cannot maintain the motion of the ball forever, if the attraction of the earth be acting upon it ; neither could the earth continue in motion by mere momentum while the attraction of the sun is acting upon it. The earth's orbit is elliptic. During six months of the year, the earth is continually approaching or falling toward the sun until she has reached her perihelion point ; during the other half of the year, she is rising or receding from the sun until she reaches the aphelion point. But the earth requires a SUSTAINING force to prevent her from falling into the sun. It is admitted by all that she is RETAINED in her circular path by attraction ; but may she not be sustained in her orbit by REPULSION ? By experiment with the electrical machine, we have discovered the LAW OF INDUCTION, which would be more clearly understood by the aid of a diagram representing two round bodies, the one marked A, the other B. If the body B be presented to any other body in a charged state, as A, but without touching, they will mutually INDUCT each other so long as they do not touch. If A be positively charged, then the further side of B will also become positively charged, although it had not been so previously to presenting B to A, and the nearer side of B will at the same time become negative, and in the same degree; accordingly, if B is composed of two pieces which may be taken apart, it will be found, on presenting each of the halves to A, that the further half will be REPELLED, and the nearer half ATTRACTED. By this law we perceive that the earth is sustained in her orbit by repulsion and retained by attraction.

Now, "the sun and moon cause tides in the ocean. These bodies, however, are perpetually changing their relative positions in the heavens, and on this account their separate actions are at alternate periods of time united and opposed to each other. The sun and moon act together twice a month, and the tides are then usually high; these are the spring tides." When the sun and moon oppose each other, which occurs twice every month, the moon being in her quadratures, there are low or neap-tides. We can clearly understand that the conjoint action of the sun and moon should cause the surface of the ocean, next those bodies, to rise; the fact and the principle of this rise mutually support each other. But there is a tide on the other side of the ocean, and various have been the methods adopted to explain the cause of it; but if the reader understands the explanation of the law of induction, he will at once perceive that the tide next the sun and moon is caused by attraction, while that on the opposite point of the globe is due to repulsion. The latter does not rise so high as the former. There must be a cause for this difference of the two tides. If, then, by momentum the earth be carried out beyond the neutral line of attraction and repulsion, the repulsive must act with less intensity than the attractive force, and consequently the tide caused by attraction rises the highest—the facts and the principles harmonize.

We assume that the solar action going on in the atmosphere is the efficient cause of the rotation of the earth on its axis. The electrical state of the atmosphere undergoes a specific change during the time that the sun is above the horizon. The rising and sinking of the electrical state of the atmosphere is not constant upon any given point of the earth. That portion of the revolving earth upon which the sun is setting is the part whereon the exciting action of the sun has been longest exerted—or, more correctly, that portion of the atmosphere wherein the specific solar action has been going on during the whole of the day, while an equal portion of the earth has been during the same length of time removed from the immediate influence of the solar action, or during the whole of the night. As we have seen, in referring to the tides, that the opposite hemispheres of the earth are attracted and repelled—that is, the hemisphere turned from the sun is repelled, and that toward the sun is attracted—then the central globe being held securely between two forces, the centre of which is in the earth herself, these forces become the pivot or axis upon which she revolves, the solar action going on in the atmosphere being the efficient cause of rotation, and thus is continued the rotary motion which is rendered equable by the centrifugal momentum with which the earth is charged.

Now, supposing the whole mass of the sun to be in a state of combustion, "how can such combustion be kept up without diminishing the material on which it feeds?" The fact of the acceleration of the moon's motion in her orbit is a part of our answer to this question. The moon has been approaching the earth for at least 2,000 years, and probably from the beginning of her existence as a body in space. It is true, we have the assurance of La Place, that this approximation has a limit, although he was unable to determine that limit. According to his doctrine, the acceleration of the moon's motion in her orbit is "caused by a gradual diminution in the eccentricity of the earth's orbit. Moreover, that this diminution will continue for ages, when it will cease, and then the eccentricity will begin in turn to increase; and that these alternate changes will continue while the solar system exists. The acceleration of the moon must therefore follow the same law. For ages the motion will grow swifter and swifter until the eccentricity of the earth's orbit begins to increase; after that era the moon's motion will be gradually slower and slower; until again, at the end of countless ages, the limit will be reached, and her speed once more accelerated."

A part of this explication evidently conflicts with our theory; nevertheless, from the fact that all the planets increase in density as they approach nearer and nearer the centre of attraction, taken in connection with other facts or phenomena, and our explication of the same, we maintain that, "at the end of countless ages," the satellites will, each at different periods of time, fall upon their primaries, and each of these, at different periods, will fall upon the sun, and be again transformed into new worlds as before explained. Not only is the moon approaching the earth, but the latter, under the same law, is also approaching the central sun. Now, the aphelion and perihelion points of the earth's orbit, as well as those of the other planets, are moving forward on the ecliptic with a slow progressive motion, requiring about 114,755 years to complete a sidereal revolution; the earth's equinoctial points are moving backward upon the ecliptic, 21,067 years being required to complete their cycle; the eccentricity of the earth's orbit is decreasing at the rate of forty-one and a half miles annually, and that of the other planets is also changing; the inclination of all the planetary orbits is decreasing; the inclination of the earth herself to the plane of the ecliptic is changing, as is also that of the other planets. In short, it may be said that no body in the entire system ever returns to the same identical position that it had previously occupied in the system.

Now, the ancient Egyptian astronomers computed the length of the solar year at three hundred and sixty-five days, six hours, and their computation would have been the correct one to the end of time, if the earth really revolved around the sun without approaching the centre. But a celebrated astronomer, who flourished a century or more before the Christian era, found that the actual length of the year was less than that computed by those Egyptian astronomers, by a quantity which he estimated at four minutes and forty-eight seconds, and since his time it has been necessary to make corrections in the length of the year. "The true length of the year 1800, as computed by Bessel, is three hundred and sixty-five days, five hours, forty-eight minutes, and forty-seven eight-tenths seconds." Thus we perceive that the year has become shorter; the difference is small, but this circumstance agrees with all the processes of nature in the vegetable, animal, and mineral kingdoms. Every operation is carried forward by slow means, and the earth approaches the centre at a slow rate.

If the moon be approaching, there was a time when she was much further from the earth than at present; if the earth was really attended by four or more moons which have been successively precipitated, the remaining one must have been the most distant of those satellites. If the earth has been approaching the centre for millions of years, there must have been a time when she revolved in an orbit as distant as that of Jupiter; and if at that time no more than one satellite had been deposited, then the earth must have been accompanied by four moons as Jupiter is now. If the satellites of Jupiter be approaching their primary, as the moon is, and the primary Jupiter also approaching the sun, like the earth, then when Jupiter has reached the earth's orbit he may not have more than one moon remaining, in which case he will be in the same condition in that respect as the earth now is; and, conversely, the earth must have been at a former period in the condition in which Jupiter is at present. So, also, if the earth be becoming denser, she must have been less dense when she moved in an orbit as distant as that of Jupiter; and by the hypothesis, Jupiter should be at present less dense than the earth. Further, if the earth be more dense now than formerly, she must be less in bulk; and, conversely, when she moved in an orbit as distant as that of Jupiter · she must have been less dense, and consequently of greater bulk. It is true that by the deposition of solid matter in the form of satellites, her solid contents may be more, but her diameter may have decreased in a much greater ratio. Now let us see whether our hypothesis be substantiated by facts.

At least seventy planets revolve around the sun, of which over sixty are termed Asteroids. "The asteroids are so small that, with the exception of one or two which have been seen without a telescope, they are invisible to the naked eye. Their diameters have not yet been accurately determined; some exceed 100 miles." The distances of the planets from the sun, and the number of moons by which they are attended, are as follows:

PRIMARIES.	DISTANCES FROM THE SUN IN MILES.	NUMBER OF MOONS.
Mercury, - - - - - - - - - - - - -	36,890,000	0
Venus, - - - - - - - - - - - -	68,770,000	0
Earth, - - - - - - - - - - - - - -	95,298,200	1
Mars, - - - - - - - - - - - - - -	145,205,000	0
Asteroids, - - - - - - - from 210 to	301,000,000	0
Jupiter, - - - - - - - - - - - -	495,817,000	4
Saturn, - - - - - - - - - - - - - -	909,028,000	8
Uranus, - - - - - - - - - - - -	1,828,071,000	4*
Neptune, - - - - - - - - - - - -	2,862,457,000	1

Here it will be observed that the planets nearest to the sun have no moons. "The fact that the more remote planets are attended by trains of satellites, and the singular unresolved appearance observed near Neptune, by English and American astronomers, render it not improbable that an assemblage of moons may at length be found around this far distant member of our system."

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* Sir William Herschel believed that he had discovered six satellites by which Uranus was attended, but we give the number according to more recent observers. If Uranus was formerly attended by six satellites, and has now but four, we venture to assume that two of them have been successively precipitated upon him.

Our theory is strengthened by the fact, that, as a general law, the planets nearer to the sun are denser and of less diameter. The density of Mercury is one-eighth greater than that of the earth, its diameter being 3,183 miles. The density of Venus and Mars is very nearly equal to that of the earth. Venus is 8,108, Earth 7,926, and Mars 4,546 miles in diameter. The density of Jupiter is about one-fourth that of the Earth; his diameter is 90,734 miles. The density of Saturn is but one-seventh that of our planet; its diameter is 76,791 miles. The density of Uranus is the same as that of Jupiter, or about one-fourth of that of the Earth; his diameter is 35,307 miles. The density of Neptune is about equal to that of Saturn, and its diameter about 40,000 miles.

We maintain that the rotation of the planets on their axes is dependent upon the internal activity of the body, the action being exerted through the agency of the sun; consequently, as the planet advances in age its internal activity becomes less. Let us examine how far the facts agree with the hypothesis. Mercury, time of rotation, 21 hours, 5 minutes; Venus, 23 hours, 21 minutes; Earth, 24 hours; Mars, 24 hours, 37 minutes; Jupiter, 9 hours, 55 minutes, 27 seconds; Saturn, 10 hours, 29 minutes, 17 seconds; Uranus, 9 hours, 30 minutes; Neptune, unknown.

We assume that the planets and satellites are maintained at their respective distances from the sun and each other by the relative quantities of positive and negative electricity with which each is charged. Now, a direct consequence of the law of electrical induction is, that if a small body weakly electrified be placed at a distance from another—a larger body more highly charged with the same species of electricity—it will be REPELLED; but there is a CERTAIN DISTANCE, within which, if it be brought, ATTRACTION will take place instead of repulsion. From this it appears, that when the moon has approached within a certain LIMIT, the repulsive will be overcome by the attractive force, and she will be precipitated upon the earth's surface. To some such an event may seem improbable; if, however, astronomers should discover, at a future time, that Jupiter is attended by no more than three moons, such discovery must be regarded as a demonstration of the truth of this theory. The diameter of his nearest moon is 2,440 miles, which is only 275 miles greater than the diameter of our planet's satellite. The distance of the moon from the Earth is 240,000 miles; and the distance of Jupiter's nearest satellite from him is 278,500 miles. But some may find it difficult to comprehend that the Earth once existed in a fluid, or in a gaseous state; yet "water offers a familiar example of a substance existing on the surface of the globe, in the separate states of rock, fluid and vapor, for water consolidated into ice is as much rock as granite or the adamant." Our investigations lead us to the conclusion, that the earth and all the planets and satellites of the solar system had their beginning in a fluid state, and that they have been and are now contracting and "running down" toward the centre of attraction, as a river runs down toward the centre of the earth. We endeavor to reason from what is known, for

"Of God above or man below,
What can we reason but from what we know."

Now, changes are going on in comets as important as those which have been going forward in the earth. "The most luminous point, seen at or near the centre of a comet, is the nucleus. The luminous trains, some long, others short, with which most comets are accompanied, whatever direction they are projected in, are called tails. Comets revolve around the sun according to regular laws, similar to those that regulate the planetary movements, only that their orbits are very long ellipses, of which the sun always occupies one of the foci; they have often nuclei resembling planets, both in shape and brilliancy. In general they are only small, but not always so. All comets in their courses traverse successively different constellations."

The comet of 1860 passed very near to the sun. Its orbit was highly eccentric, and the tail was suddenly expanded to an enormous length. The sudden expansion of the tail proves that the physical constitution of the comet was of a character highly volatile. If we conceive of it as a globe of liquid matter in a nascent state, as a condensation or contraction of the solar gaseous fluid, formed in the external or upper regions of the solar system, in a manner analogous to the formation of a rain-drop in the upper region of the terrestrial atmosphere, we seem to have obtained all that is requisite to illustrate and explain the origin of a comet, namely, that it has been formed by the contraction of matter; which matter had previously ascended from the central sun in an expanded or gaseous and invisible form; and that as a consequence of this contraction it again seeks the centre, falling toward the sun, until by the excitement or action of the sun upon the nascent liquid, an enormous tail of expanded matter is formed; in consequence of which expansion the body again recedes from the centre under the influence of the universal law by which all expanded matter ascends or recedes from the central solid with which it is connected. The matter of which a rain-drop is composed recedes from the central earth in an expanded or gaseous and invisible form. This invisible expansion of terrestrial gas is contracted into a little globe of liquid matter, in a point of space more distant from the centre of the earth than that at which it was expanded; and this little globe of nascent liquid returns toward the centre in the form of a raindrop, a portion of which passes onward into the vegetable kingdom, where it takes the solid form. The analogy is perfect. But if expanded matter be issuing from the sun, and no supply in the meantime is carried to him to compensate the loss, then he must at length be dissipated and scattered in space; and if all bodies at present revolving in the solar system be approaching the sun, and no new bodies in the meantime are forming, then the planetary system must come to a termination; but if the two opposite processes compensate each other, then the system may go on forever.

Now, how is the expanded matter which issues from the sun gathered together in large GLOBULAR masses as comets? The efficient cause is attraction; but there are other aids which co-operate with attraction. It is a law of nature, that all fluid matter when in motion proceeds in a SPIRAL or twisting course. Bore a small hole through the bottom of a pail filled with water, and it will be seen that the water issues through the hole with a spiral motion. Vegetables are formed from fluid matter, and as it moves with a spiral motion, the vegetable structure condenses or contracts in the form of the moving fluid. With French beans, hop vines, and other climbing plants, which always climb around their support in the same direction, this law is manifested, and it is a law intimately connected with electrical action, for, as on the one hand, the bean, or the hop vine is attracted and clings closely to the dried stock which is placed for its support, so, on the other, it is repelled and turns away from a newly-cut branch, placed for its support, because the latter and the growing vegetable are in the same electrical states, and consequently repel each other; whereas the dried branch support and juicy vegetables, being in opposite states, attract each other. Potassium, when thrown upon water, rotates in a spiral course during the continuance of the action which accompanies its oxydation. "The discovery of a number of nebulæ presenting the appearance of spirals or whirlpools, has lately rewarded the researches of astronomers. They are a singular class of stellar objects, altogether different from any before known, requiring the very finest telescopes to reveal their structure."

We conclude, then, that by the effect of a constantly rolling and twisting motion in the distant regions in the solar system, the condensing or contracting mass must be rolled together into GLOBULAR MASSES, which, consisting of partially condensed matter, possess all the characteristics of a comet without a tail; and such is the state in which a comet is found to exist when perceived at a distance from the sun.

Sir John Herschel speaks of the sun as being in a state of combustion, of an intensity so great that no conflagration on earth can afford us a medium of comparison with a body in so high a degree of incandescence; and that "the great mystery is to conceive how so enormous a conflagration, if such it be, can be kept up." But what is the necessity of such a very high degree of heat in the sun as has been assumed by Herschel and others? A heat that will convert solid matter into gas is all that is required to produce the ordinary phenomena of light and heat in the earth's atmosphere, by combination with a gas or gases issuing from the sun.

Now, by the aid of powerful telescopes, "the sun is observed to have frequently large and perfectly BLACK SPOTS upon it," says Sir John Herschel, "surrounded with a kind of border less completely dark, called a penumbra. They are, however, not permanent. When watched from day to day, or even from hour to hour, they appear to enlarge or contract, to change their forms, and at length to disappear altogether, or to break out anew in parts of the surface where none were before. In such cases of disappearance, the central dark spot always contracts into a point, and vanishes before the border. Occasionally they break up and divide into two or more, and in those offer every evidence of that extreme mobility which belongs only to the fluid state, and of that excessively violent agitation which seems only compatible with the atmospheric or gaseous state of matter. The scale on which their movements take place is immense. . . . Spots have been observed on the sun whose linear diameter has been upward of 45,000 miles. . . . The part of the sun's disk not occupied by spots is far from being uniformly bright. Its ground is finely mottled with an appearance of minute dark dots or pores, which, when attentively watched, are found to be in a constant state of change. There is nothing which represents so faithfully this appearance as the slow subsidence of some flocculent chemical precipitates in a transparent fluid, when viewed perpendicularly from above."

That the SPOTS are not mountains of the sun laid bare is evident, for THEY SHIFT their position like a solid body floating in a liquid, and they disappear like a solid body sinking in a liquid; they vanish to a POINT and reappear in a similar manner. If the reader will attentively consider all that is going on in the cometary and planetary systems, together with the kind of action going on in the sun itself, respecting the BLACK ROUND SPOTS of many thousands of miles in diameter, he will find some difficulty in the attempt to persuade himself that these SPOTS are not, in fact, OLD PLANETS in a state of decomposition, THE MATE-

RIALS BY WHICH THE EVERLASTING ACTION OF THE SUN IS SUSTAINED.

In the works of nature, if the action of expanding be extreme, the reaction of contracting must also be extreme. If the oscillation of the pendulum be great on one side of the perpendicular, it will be great on the other side, also, by reaction. In the physical world action and reaction is the universal law; and the same holds in morals. War begets poverty, poverty begets humility, humility begets peace; peace begets plenty, plenty begets pride, pride begets war; war begets poverty, etc., and so on round the circuit, like the rain-drop in the atmosphere, or the planets in the solar system. Again: monarchy leads to oppression, oppression leads to resistance, resistance leads to liberty, liberty to licentiousness, licentiousness to anarchy, anarchy to suffering, suffering to submission, submission to monarchy, and monarchy to oppression. Action and reaction may be traced in all things, for the system of nature is a system of motion or action. The life of man is a portion of the universal process; and all that remains for us to do is to press forward, avoiding violent action, that thereby we may escape the violent reaction which is sure to follow.

Aristotle concludes the twelfth chapter of his Meteorics with the following remarkable philosophical observations: "As time never fails, and the

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universe is eternal, neither Tanais nor the Nile can have flowed forever. The places where they rise were once dry, and there is a limit to their operations; but there is none to time. So also of the other rivers; they spring up and they perish; and the sea also continually deserts some lands, and invades others. The same tracts, therefore, of the earth, are not, some always sea, and others always continent; but everything changes in the course of time."

In the third chapter of 2 Peter are these words: "And the elements shall melt with fervent heat, the earth also, and the works that are therein shall be burnt up. . . . Nevertheless we, according to HIS promise, look for new heavens and a new earth wherein dwelleth righteousness."

In reference to the *meteoric* theory of solar light and heat, propounded by a German physician, Mayer—namely, that the many meteoric bodies revolving about the sun must be drawn into that luminary and thereby keep up his combustion—Tyndall says: "The potential energy of gravitation was the original form of all the energy in the universe. As surely as the weights of a clock run down to their lowest position, from which they can never rise again unless fresh energy is communicated to them from some source not yet exhausted, so surely must planets creep in, age by age, toward the sun. When each comes within a few hundred thousand miles of his surface, if he is still incandescent, it must be melted and driven into vapor by radiant heat. Nor, if he be crusted over and become dark and cool externally, can the doomed planet escape its fiery end."

THE END.

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